A Study on the Measurement Method of Check Source for Coincidence Summing Corrections using Marinelli Beaker

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1. Introduction

After the Fukushima nuclear accident, research began on the effects of radioactivity in daily life due to the accident in earnest. In the past, radioactivity measurement was measured to evaluate the radioactivity of nuclear-related facilities and their surroundings, but recently as the radioactivity measurement in daily life has mentioned and required it are gradually expanding. These radioactivity measurements should be more accurate than anything else. In particular, it can be said that it is important to pursue more accuracy than other measurements, because in the case of radioactivity around life trace amounts of radioactivity are measured. Accordingly, the academia introduced the concept of measurement uncertainty, the concept of a correction factor for this purpose is also introduced and implemented.

The correction factors in the representative gamma radiation measurement can be roughly divided into five categories. There are factors such as the decay correction factor for the time elapsed between the measurement time after sample collection(K_1), the correction factor for radioactive decay during the measurement time (K_2), self absorption correction factor for the characteristics of the sample(K_3), the accidental random coefficients due to the characteristics of the measured nuclides(K_4) and a coincidence summing corrections due to the characteristics of the measured nuclides(K_5).

These are different the method of performing each correction factor. Check Source is often used to correct the coincidence summing corrections. However, when the check source is used, the radioactivity count is too large, resulting in a significant increase in the dead time of the measurement time. This increase has a disadvantage in that it lowers the reliability of the measurement and greatly reduces the validity of the measurement result. This study, method to reduce the dead time using Marinelli Beaker was studied for the check source used to correct the shortcomings of the coincidence summing corrections and its effectiveness was also explored.

2. Methods and Results

2.1 Material & Methods

Coincidence summing correction often occurs in nuclides with multiple energies due to the characteristics of nuclides. For example, Co-60 is a characteristic that radioactivity is collected at 1,173 keV and 1,332 keV, but a peak is observed at 2,500 keV such a synthesis of the two between measurements, which refers to a phenomenon in which radioactivity is collected. It is the coincidence summing correction factor(K_5) that corrects this phenomenon.

The check source which is mainly used for coincidence summing correction(K_5) was utilized in this study(Fig 1), Cs-137 check source which is a relatively long-lived radionuclide was used in order to minimize the measurement uncertainty for other factors during the study. An important point in this measurement is considered dead time between measurements should be as short as possible. Because the dead time can affect the evaluation of measurement effectiveness. In some institutions is recommended to use a separate frame for each measurement laboratory.

Fig 1. Source used as Coincidence summing correction

You can make a frame and use the check source to set the optimal distance, but it is not easy to find this optimal distance. Even if the frame is made accordingly, there are many variables such as the state of the check source and the geometrical structure placed on the measuring instrument, so there is a limit to confirming and manufacturing the depth of this frame. In this study, a simple frame was made and measured using a commonly used Marinelli Beaker. This is a simpler way to measure because you do not need to create a separate frame. To evaluate the effectiveness, measurements were made three times each at 0, 3, 7 and 14cm as Fig 2.

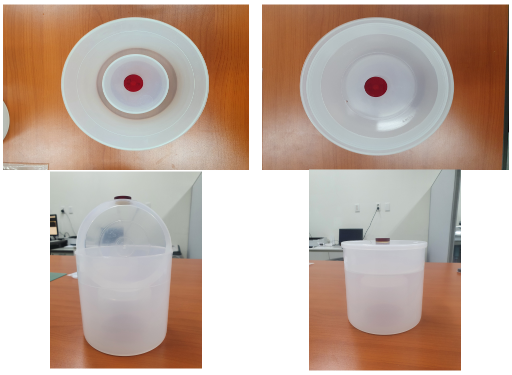

Fig 2. Check Source position at each distance (0 cm top left, 3 cm, 7cm, 14 cm Clockwise)

This showed the location of the check source by height. In the case of 0 cm it was measured by attaching it to the Marinelli Beaker measuring part, 3 cm was placed in line with the baseline. 7 cm was fixed to the upper part of the Marinelli Beaker. 14 cm was measured by turning the frame of the baseline by 90° and fixing the check source at the uppermost part.

2.2 Result & Discussion

Table 1 shows the radioactivity measurement evaluation results by distance for the check source.

Table 1. Measurement result by distance

<table>
<tr><td>Distance</td><td colspan="2">0 cm</td><td colspan="2">3 cm</td></tr>
<tr><td>Dead time</td><td colspan="2">4.73%</td><td colspan="2">1.50%</td></tr>
<tr><td rowspan="2">Activity</td><td colspan="2">Measurement</td><td>Mean</td><td>Rate</td></tr>
<tr><td colspan="2">45589</td><td>13101</td><td>Ap. 30%</td></tr>
<tr><td>Distance</td><td colspan="2">7 cm</td><td colspan="2">14 cm</td></tr>
<tr><td>Dead time</td><td colspan="2">0.58%</td><td colspan="2">0.24%</td></tr>
<tr><td rowspan="2">Activity</td><td>Mean</td><td>Rate</td><td>Mean</td><td>Rate</td></tr>
<tr><td>4486.4</td><td>Ap. 90%</td><td>1344.8</td><td>Ap. 95%</td></tr>
</table>

Since the radioactivity is underestimated as the distance increases, it is necessary to know about the reduced value compared to the actual measurement to be able to calibrate the radioactivity when performing future corrections.

Compared to the 0 cm measurement the 3 cm measurement showed about 1/3 as the reduction rate was about 30%, but it was judged that it was unreasonable to say that the validity of the measurement was secured because the dead time was measured as 1.50%. At 7 cm, the dead time was effectively measured as 0.58%, and the decrease rate was also about 90%, which was found to be 1/10, and 14 cm, the decrease rate was 0.24% and about 95%. 14 cm was found to be excessively underestimated.

As a result of these measurements, the most appropriate result was 7 cm measurement, the dead time was within 1% to ensure the validity of the measurement.

3. Conclusions

In gamma nuclide analysis, it is realistic to measure by dropping the check source for effective measurement by reducing the dead time to reduce the simultaneous synthesis effect. While research on coincidence summing corrections is expected to be active for accurate measurement in gamma nuclide analysis, this study will be able to contribute to making detailed guidelines for coincidence summing corrections.

REFERENCES

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